Sensor Network-Based Indoor Localization and Tracking for Emergency Situations

Hewa Halpage Samiru Gayan

(138030 H)

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Department of Electronic and Telecommunication Engineering

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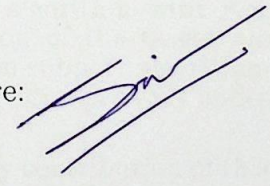
Signature:  Date: 02/04/2015

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Abstract

Wireless Sensor Networks (WSNs) are application-specific systems, each having its own requirements related to the design. Using WSNs for emergency rescue operations is one such special application having localization of sensor nodes in a simple manner, tracking of moving nodes, usually worn by rescue workers and navigation support for rescue workers, as its major requirements. The overall objective of this research is to develop a suit of algorithms for localization, tracking and navigation of wireless sensor nodes in multistory indoor environments in emergency situations.

We base our research on the DV-Hop (Distance Vector) algorithm, which is an attractive option for the localization of nodes in a wireless sensor network due to its simplicity. We carry out a comprehensive study of the DV-Hop algorithm and its variations through literature review and computer simulations. We then evaluate its performance in emergency situations, where nodes may perish, new nodes may be introduced, and communications links may be disrupted and new links set up. We then propose a new algorithm for the improvement of localization accuracy of the DV-Hop algorithm. The new algorithm is based on optimizing the Hop Size estimation in the original algorithm, which is its key source of error.

We next present a new approach for target tracking in WSNs by combining the DV-Hop algorithm with Kalman filtering. The DV-Hop algorithm is used for pre-localization of the target and measurement conversion. Finally, we present a novel navigation support algorithm for rescue personnel in emergency situations by emulating virtually through WSN nodes, the *lifeline* used by the fire fighters.

The key contribution of this work is the development of WSN localization and tracking techniques which are distributed in nature and resilient in emergency situations.

Index terms— DV-Hop, Localization, Wireless Sensor Networks, Target Tracking, Navigation Support

To My Parents

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List of Abbreviations

Abbreviation	Description
WSN	Wireless Sensor Network
BS	Base Station
GPS	Global Positioning System
MDS	Multi-Dimensional Scaling
DV-Hop	Distance Vector Hop
TOA	Time of Arrival
TDoA	Time Difference of Arrival
RSS	Received Signal Strength
AOA	Angle of Arrival
APIT	Approximate Point in Triangulation
MSP	Multi-Sequence Positioning
RSSI	Received Signal Strength Indicator
CoG	Center of Gravity
EKF	Extended Kalman Filter
PDF	Probability Density Function
CDF	Cumulative Distribution Function
PSO	Particle Swarm Optimization
RMSE	Root Mean Square Error